New Hampshire Volunteer Lake Assessment Program

2003 Interim Report for Contoocook Lake Jaffrey

NHDES
Water Division
Watershed Management Bureau
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **CONTOOCOOK LAKE, JAFFREY,** the program coordinators have made the following observations and recommendations:

As you are aware, the Franklin Pierce College (FPC) satellite VLAP laboratory was not able analyze samples during the 2003 sampling season. This was largely due to personnel and budget issues at the college. Although the FPC laboratory was not able to analyze samples, staff at FPC continued to lend out sampling equipment to volunteer monitors in this area. This was truly a cooperative effort between DES, FPC, and the volunteer monitors in this region. We want to thank you again for bearing with us this season. Also, we want to assure you that DES and FPC are working together to get the FPC lab up and running for the 2004 sampling season. We will keep you posted on the status of the laboratory as the sampling season approaches.

Thank you for your continued hard work sampling the lake/pond this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity.

The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.

The current year data (the top graph) show that the chlorophyll-a concentration ***increased greatly*** from June to July, and then ***decreased*** from July to August. The chlorophyll-a concentration in July was ***greater than*** the state mean.

The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***less than*** the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows ***variable, but overall stable*** in-lake chlorophyll-a trend, meaning that the concentration has ***fluctuated, but has not continually increased or decreased,*** since monitoring began in 1994. In the 2004 annual report we will conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  The current year data (the top graph) show that the in-lake transparency ***remained relatively stable*** from June to July, and then ***decreased*** from July to August. The transparency on each sampling event was ***less than*** the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***slightly decreasing (meaning worsening)*** trend for in-lake transparency since monitoring began in 1994. As discussed previously, in the 2004 annual report, we will conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  The current year data for the epilimnion (the top inset graph) and the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased*** from June to July, and then ***decreased slightly*** from July to August.

  The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***slightly greater than*** the state median.

  The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***approximately equal to*** the state median.

Overall, visual inspection of the historical data trend line for the epilimnion show a ***slightly increasing (meaning worsening)*** phosphorus trend since monitoring began.

Overall, visual inspection of the historical data trend line for the hypolimnion shows a ***slightly decreasing (meaning improving)*** phosphorus trend.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed this year was ***Anabaena*** **(a cyanobacteria).**

  An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans. (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

  The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

  In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH at the deep spot this season ranged from **6.17** in the hypolimnion to **6.37** in the epilimnion, which means that the water is ***slightly acidic.***

  The annual mean pH of **Cochrane Inlet East** (4.94) and **Cochrane Inlet West** (4.49) continued to be ***low.***

  Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

  Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

  Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) annual mean this season was **3.53 mg/L**, which is ***much less than*** the state mean. Specifically, this indicates that the lake/pond is ***highly sensitive*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**
  Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The conductivity has ***increased*** in the lake/pond and inlets since monitoring began. The conductivity at the deep spot was approximately **90 uMhos/cm** this season, which is the ***highest*** annual mean since monitoring began and is ***greater than*** the state mean.

  In addition, the mean conductivity this season in **Squantum Inlet** (245.5 uMhos/cm), **Taft Inlet** (484 uMhos/cm), and **Woodbound Inlet** (253 uMhos/cm) was ***very high***.

  Typically, sources of elevated conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

  We recommend that your monitoring group conduct storm event sampling along the inlet(s) with elevated conductivity so that we can determine what may be causing the increases. In addition, we recommend that these inlets be sampled for Chloride, Sodium, and Magnesium (the major cations and anions that may cause elevated conductivity levels).

  For a detailed explanation on how to conduct storm event sampling and cation/anion sampling, please contact the VLAP Coordinator.

- **Table 8: Total Phosphorus**
  Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The total phosphorus annual mean concentration was ***elevated*** in the **Cochrane Inlet East** (50 ug/L), **Squantum Inlet** (128 ug/L), **and**

Taft Inlet (54 ug/L) this season. These station have had a history of ***elevated*** and ***fluctuating*** total phosphorus. The turbidity (Table 11) at these stations was also elevated this season. (Please refer to the discussion of Table 11, on page 28, for further discussion).

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***high*** in the epilimnion and metalimnion at the deep spot of the lake/pond on the June sampling event. However, the oxygen was ***much lower*** in the hypolimnion. As lakes/ponds age, and as the summer progresses, oxygen becomes ***depleted*** in the hypolimnion (lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it has been in many past seasons)**, the phosphorus that is normally bound up in the sediment may be re-released into the water column.

  The ***low*** oxygen level in the hypolimnion is a sign of the lake's/pond's ***aging*** and ***declining*** health. This year the DES biologist conducted the temperature/dissolved oxygen profile in ***June (and has done so since 1994).*** We recommend that the annual biologist visit for the 2004 sampling season be scheduled during ***August*** so that we can determine if oxygen is depleted in the hypolimnion ***later*** in the sampling season.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

As discussed previously, the turbidity level in the **Cochrane Inlet East, Squantum Inlet, and Taft Inlet** samples was elevated this season. In addition, sediment was observed in these sample bottles. This data and observations suggest that the stream bottom may have been disturbed while sampling or that erosion is occurring in these portions of the watershed.

When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

If you suspect that erosion is occurring in these portions of the watershed, we recommend that your monitoring group conduct stream surveys and storm event sampling along these inlets. This additional sampling may allow us to determine what is causing the elevated levels of turbidity.

For a detailed explanation on how to conduct storm event sampling and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 12: Bacteria (*E.coli*)**

Table 12 lists the current year data for bacteria (*E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms **MAY** also be present.

The *E.coli* concentration was **low** at each of the sites tested this season, except for at **Townline Inlet.** The *E. coli* concentration at **Townline Inlet** was **elevated** on the July 29 sampling event. However, the concentration of **130** counts per 100 mL ***was not greater than*** the state standard of 406 counts per 100 mL for recreational waters that are not designated beaches.

If you are concerned about *E. coli* levels at this station, your monitoring group may want to conduct rain event sampling and bracket sampling in this area. This additional sampling may help us determine the source of the bacteria.

For a detailed explanation on how to conduct storm event sampling and bracketing sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Additional Sampling: Lead**
  The epilimnion and hypolimnion was sample for lead on one occasion this summer. The results were ***very low***, and ***less than*** the state standards for drinking water. This is good news!

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a ***very good*** job when collecting samples this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few aspects of sample collection that the volunteer monitors could improve upon. They are as follows:

- **Sample Bottle Volume:** Please remember to fill the *E.coli* bottles completely, leaving no room for air bubbles. This will ensure that the sample is not contaminated.

NOTES

- **Biologist's Note (6/12/03):** The total phosphorous in Squantum Inlet and Taft Inlet was elevated. The conductivity was also elevated in Taft Inlet.

  (7/29/03): The total phosphorous levels in Cochrane Inlet East, Squantum Inlet, and Taft Inlet were very high. The E. Coli level at Townline Inlet was high.

  (8/28/03): The total phosphorous level at Squantum Inlet was found to be high.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, *NHDES-WD 97-8*, NHDES Booklet, (603) 271-3503.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Is it Safe to Eat the Fish We Catch? Mercury and Other Pollutants in Fish, NH Department of Health and Human Services pamphlet, 1-800-852-3345, ext. 4664.

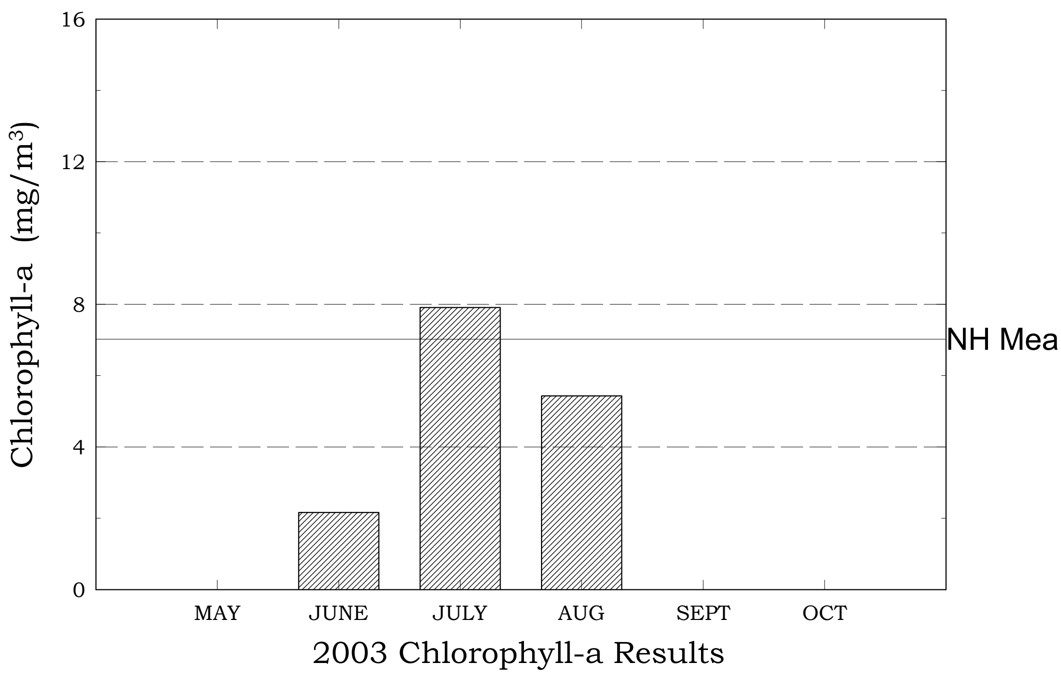
Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

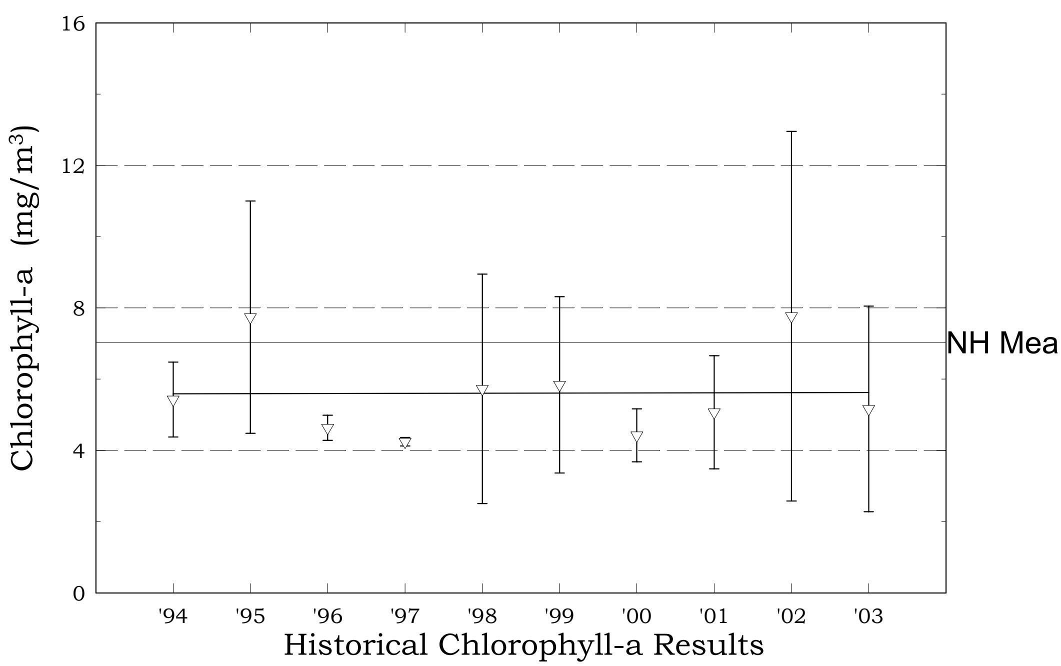
APPENDIX A

GRAPHS

Contoocook Lake, Jaffrey

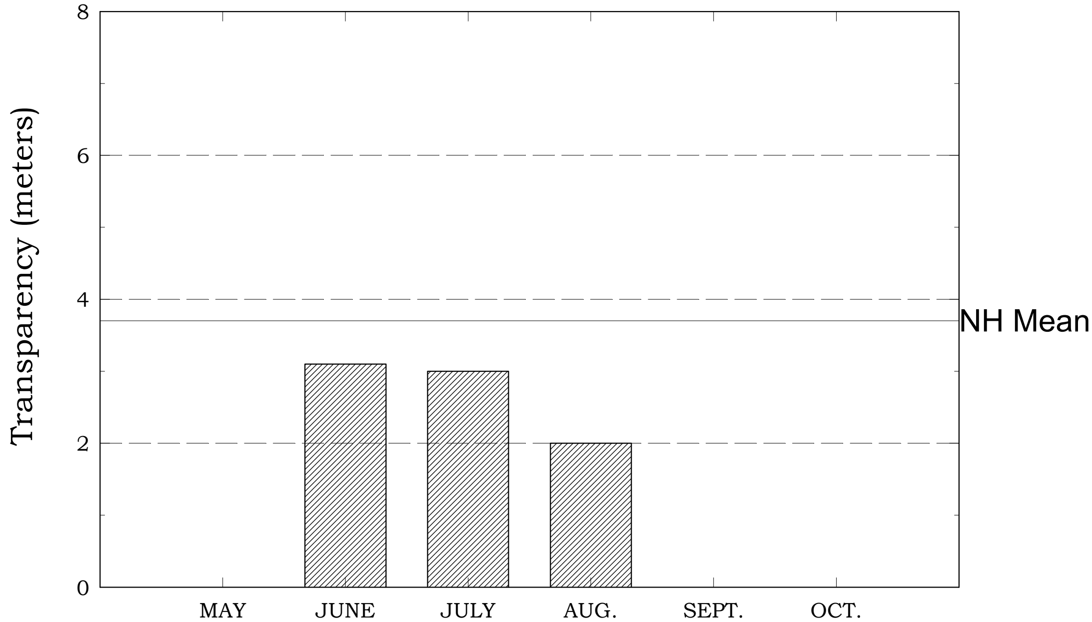
Figure 1. Monthly and Historical Chlorophyll-a Results



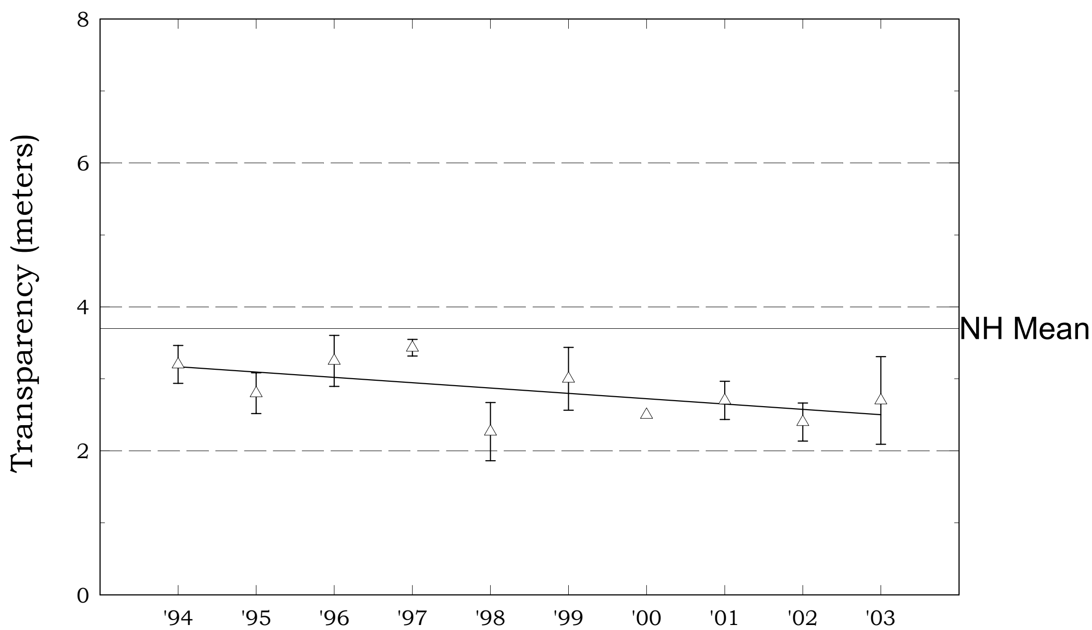


Contoocook Lake, Jaffrey

Figure 2. Monthly and Historical Transparency Results



2003 Transparency Results



Historical Transparency Results

Contoocook Lake, Jaffrey

Figure 3. Monthly and Historical Total Phosphorus Data.